City Blueprint Assessment in 3 Central African Cities: A Contribution for the improvement of Urban Water Security

Ibrahima Abdoulahi[1], Djibrilla Mohamadou[1], Annie-Claude Nsom Zamo[1], Steven H.A. Koop[2,3], Ovenga Gwladis[1], Grekonzy Vanessa[1]

[1] Intergovernmental Hydrological Programme (IHP), Natural Sciences Sector, UNESCO, POBOX 12909 Yaoundé, Cameroon; ibrabdoulahi@gmail.com (I.A); d.mohamadou@unesco.org (D.M) ; ac.nsom-zamo@unesco.org (A.C)

[2] KWR Water Research Institute, Groningenhaven 7, 3433 PE Nieuwegein, The Netherlands; stef.koop@kwrwater.nl (S.K.)

[3] Copernicus Institute of Sustainable Development Utrecht University, Princeton laan 8a, Utrecht 3584 CB, The Netherlands

KEYWORDS

City Blueprint Approach - Trends and Pressures Framework – City Blueprint Framework - Governance Capacity Framework – Water management

ABBREVIATIONS

BCI: Blue City Index

CAR: Central African Republic

CBF: City Blueprint Framework

GCF: Governance Capacity Framework

IHP: Intergovernmental Hydrological Programme

IWRM: Integrated Water Resources Management

NGO: Non-Governmental Organization

TPF: Trends and Pressures Framework

UNESCO: United Nations Educational, Scientific and Cultural Organization

WWT: Waste Water Treatment

ABSTRACT

The strength of City Blueprint Approach lies in the fact that this tool can help large cities in their decision-making, in particular in assessing management challenges related to water, waste and climate change. In the present paper, we have tried to identify priorities in the way of addressing integrated water challenges in Central African cities: Bangui, Libreville and Yaounde. We have tested the City Blueprint® approach, which is based on three assessments indicators: (1) the Trends and Pressures Framework (TPF), (2) the City Blueprint Framework (CBF) and (3) the water Governance Capacity

Framework (GCF). The TPF summarizes the key social, environmental, financial and governance pressures that can hinder water management. The CBF provides an integrated overview of a city's management performances. Finally, the GCF provides a framework through which are identified the main obstacles and opportunities for developing governance capacity. It appears from the results obtained that, vulnerability to river flooding and economic pressure have a great impact on the water sector in Central African cities and wastewater treatment can be improved in these cities. Sometimes, only wastewater is only submitted to a few part of primary and secondary treatment, leading to large-scale of pollution. Yaoundé's water governance and more specifically smart monitoring and evaluation of projects and cross-stakeholder learning are capacity-building priorities.

1 INTRODUCTION

Cities in developing countries face recurrent weather events, including floods and droughts, which hamper the provision of basic services. This situation is likely to worsen as a result of climate change and rapid urbanization. It is estimated that by 2050, 87% of the population will live in cities while at the same time the supply of water will be 40% less than demand. Cities are therefore obliged to adapt their water management to avoid falling prey to inaction and growing social inequalities. But how can a city quickly understand which elements of its water cycle are already sustainable and which ones need to be adapted? The City Blueprint is a practical communication tool that can help cities on their way to becoming water sustainable cities.

The City Blueprint approach is a diagnostic tool for Integrated Water Resources Management (IWRM) in cities. It is being integrated into the operational framework of UNESCO's Intergovernmental Hydrological Program (IHP) and is composed of three complementary frameworks: (i) the Trends and Pressures Framework (TPF), which is a framework for the challenges of cities, (ii) the City Blueprint Framework (CBP) for urban water management performances and (iii) the Governance Capacity Framework (GCF). The TPF and CBF have been applied in 125 cities across the globe, the relatively new GCF has been applied in about 15 cities, including Amsterdam, Quito (Ecuador), Melbourne, New York, Seoul, Cape Town, Bandung (Indonesia) and Ahmedabad (India) (EIP Water, 2020c). It is an important tool for understanding and developing a framework for water resources management in cities to contribute to the prevention of disaster risks in particular, and to improve the resilience and living conditions of populations. Hence, it may be a useful tool to apply in African regions. Accordingly, we aim to identify priorities for responding to integrated water challenges in Central African cities. To do so, we apply the City Blueprint Approach in three Central African capitals (Bangui in Central Africa Republic, Libreville in Gabon and Yaoundé in Cameroon). This article is structured as follows: section 2 provides the methodological description of the City Blueprint Approach. Section 3 reports the assessment's results and finally section 4 ends with the conclusion.

2 METHODS

The City Blueprint Approach

In order to identify priorities for addressing integrated water challenges in Central African cities, we apply the City Blueprint Approach. Through this methodological approach, we identify the main challenges, highlight water management priorities and give recommendations based on the analysis of these three Central African cities. The City Blueprint Approach is a diagnostic tool for assessing the sustainability of IWRM that consists of three complementary frameworks. First, the main challenges of the cities are assessed using the Trends and Pressures Framework (TPF; EIP Water, 2020a). Second, the question how cities manage their water systems is assessed using the Blueprint for Cities Framework (CBF; EIP Water, 2020b). Third, areas where cities can improve their water governance are assessed using the Governance Capacity Framework (GCF; EIP Water, 2020c; Van Leeuwen et al., 2019). By the end of 2020, this tool has been tested in approximately 125 municipalities in over 40 countries (EIP Water, 2020; Koop and Van Leeuwen, 2015a).

The Trends and Pressures Framework (TFP)

The TPF consists of 24 indicators under the following broad categories: social pressures, environmental pressures, financial pressures and governance (Table 1). Each indicator is scaled from 0 to 10 points, with a higher score representing a greater pressure or concern in which water managers have to operate (Koop and Van Leeuwen, 2015a; Koop and Van Leeuwen, 2015b). Most indicator scores are calculated from international data sources, for example, the World Bank (World Bank, 2019) and some Non-Governmental Organizations (NGOs). Details of the indicators, data sources and examples of calculations are presented in the online (EIP Water, 2020a).

Table 1: Indicators of the Trends and Pressures Framework.

Categories		Indicators	Indicator number
Social pressures	Urbanization rate		1
	Burden of disease		2
	Education rate		3
Environmental pressures	Flood risk	Urban drainage flood	4
		Sea level rise	5
		River peak discharge	6
		Land subsidence	7
	Water scarcity	Freshwater scarcity	8
		Groundwater scarcity	9
		Sea water intrusion	10
	Water quality	Surface water quality	11
		Biodiversity	12
	Heat risk	Heat island	13
	Air quality		14
Financial pressures	Economic pressure		15
	Unemployment rate		16

	Poverty rate	17
	Inflation	18
Governance	Voice end accountability	19
	Political instability	20
	Government effectiveness	21
	Regulatory quality	22
	Rule of law	23
	Control of corruption	24

The City Blueprint Framework

CBF is a baseline assessment that evaluates the actual state of IWRM in a city and shows the indicator scores in a spider diagram (Koop and Van Leeuwen, 2015a; Koop and Van Leeuwen, 2015b). The result of this assessment is the first in the strategic planning process for IWRM in cities (EIP Water, 2020b). The CBF consists of 24 indicators divided into seven broad categories (Table 2). All 24 indicators are rated from 0 (low performance) to 10 (high performance). The CBF provides an in-depth understanding of the main challenges and can help prioritise IWRM management options. The geometric mean of these indicators is the Blue City Index (BCI; Koop and Van Leeuwen, 2015a; Koop and Van Leeuwen, 2015b). Details of the indicators, data sources and examples of calculations are available online (EIP Water, 2020b).

Table 2: Indicators of the City blueprint framework.

Categories	Indicators
Basic water services	1. Access to drinking water
	2. Access to sanitation
	3. Drinking water quality
Water quality	4. Secondary WWT
	5. Tertiary WWT
	6. Groundwater quality
Wastewater treatment	7. Nutrient recovery
	8. Energy recovery
	9. Sewage sludge recycling
	10. WWT energy efficiency
Water infrastructure	11. Stormwater separation
	12. Average age sewer
	13. Water system leakages
	14. Operation cost recovery

Solid waste treatment	15. Solid waste collected
	16. Solid waste recycled
	17. Solid waste energy recovered
Climate robustness	18 Green space
	19 Climate adaptation
	20 Climate-robust buildings
Plans and actions	21 Management and action plans
	22 Water efficiency measures
	23 Drinking water consumption
	24 Attractiveness

Based on BCI and similarities in indicator scores, cities are classified into the following five categories provided in Table 3 (Koop and Van Leeuwen 2015b; EIP Water, 2020d).

Table 3: Categorization of different levels of IWRM (Koop and Van Leeuwen 2015b).

BCI score	Categorization of different levels of sustainable IWRM in cities
0 – 2	Cities lacking basic water services
2 – 4	Wasteful cities
4 – 6	Water efficient cities
6 – 8	Resource efficient and adaptive cities
8 – 10	Water wise cities

The Governance Capacity Framework

Governance capacity was analysed to address these challenges with GCF by interviewing stakeholders and water authorities (government institutions, NGOs, universities, research officers, authorities). GCF is analysing the capacity of all stakeholders involved to together govern a specific water challenge. The first city in which this assessment was carried out is the city of Amsterdam (Koop et al., 2017). The GCF is a standardized methodology for assessing governance aspects (Table 4) on, for example, IWRM, water scarcity, flood risk, wastewater treatment, solid waste treatment, urban heat islands and/or water reuse. This is done by conducting semi-structured interviews with stakeholders from relevant authorities, government agencies and researchers to assess the local situation. The GCF is structured in three dimensions (knowledge, will and empowerment), nine key conditions and 27 indicators (Table 4; EIP Water, 2020c). A Likert-type scale is used to provide scores on each indicator,

ranging from very encouraging (++) to very limiting (--) (Koop et al., 2017; Madonsela et al., 2019; Van Leeuwen et al., 2019; Ddiba et al., 2020).

Table 4: Governance Capacity Framework indicators.

Dimensions	Conditions	Indicators
Knowing	1 Awareness	1.1 Community knowledge 1.2 Sense of urgency 1.3 Behavioural internalisation
	2 Useful knowledge	2.1 Information availability 2.2 Information transparency 2.3 Knowledge cohesion
	3 Continuous learning	3.1 Smart monitoring 3.2 Evaluation 3.3 Cross-stakeholder learning
Wanting	4 Stakeholder engagement process	4.1 Stakeholder inclusiveness 4.2 Protection of core values 4.3 Progress and variety of options
	5 Management ambition	5.1 Ambitious and realistic goals 5.2 Discourse embedding 5.3 Management cohesion
	6 Agents of change	6.1 Entrepreneurial agents 6.2 Collaborative agents 6.3 Visionary agents
Enabling	7 Multi-level network potential	7.1 Room to manoeuvre 7.2 Clear division of responsibilities 7.3 Authority
	8 Financial viability	8.1 Affordability 8.2 Consumer willingness-to-pay 8.3 Financial continuation
	9 Implementing capacity	9.1 Policy instruments 9.2 Statutory compliance 9.3 Preparedness

Data Collection

The data needed to calculate the TPF and CBF indicators are collected from publicly available sources, such as international databases, national and local reports, government websites and scientific articles. The data is collected jointly with local stakeholders (i.e., municipal officials, departmental representatives, NGOs and water and sanitation user groups), who provide feedback and additional input on preliminary results. The GCF data was collected by conducting fifteen semi-structured qualitative interviews. The interviews were conducted with respondents who work for the state or city government and with respondents who work for non-governmental organizations (NGOs) that are influential in water governance in Yaoundé. An independent research institute - KWR Water Research Institute located in the Netherlands - provided feedback to ensure consistency of indicator scores with other cities that were assessed using the City Blueprint approach. In this way, the exchange of learning practices between cities is enabled.

3 RESULTS

Trends and Pressures Framework

For all TPF indicators, the scores range from no concern to great concerned. Two indicators score a "great concern" for Bangui: the education rate and the unemployment rate. Libreville has five indicators of "great concern": urbanization rate, vulnerability to river flooding, economic pressure, unemployment rate and poverty rate. Yaoundé, on the other hand, has eight indicators of "great concern":, floods, vulnerability to river floods, land subsidence, surface water quality, air quality, economic pressure, political instability and corruption. Pressures can hamper the efforts of water managers to provide good urban water services, as measured by CBF.

City Blueprint Framework

The scores for the 24 CBF indicators are presented in Figure 1. The three Central African cities score relatively low on all City Blueprint indicators, with several possibilities for improvement. All these cities score high on drinking water consumption. A high score for drinking water consumption means that people do not consume a lot of water. The City Blueprint indicators for which rather low scores are observed are: tertiary wastewater treatment; groundwater quality; solid waste recycled; energy recovered from solid waste; nutrient recovery from wastewater; average age of sewers; energy recovery from wastewater; sludge recovery; energy efficiency; storm water separation; water systems leakages and green spaces. Some indicators do not score high because of the social, environmental and financial pressures that these cities face. On the basis of overall performance, cities can be ranked according to the BCI scores assigned to each of them (Table 3). Libreville and Yaoundé, with BCI scores between 2 and 4, are classified as wasteful cities, while Bangui (BCI 1.9) is classified as a city with insufficient basic water services. Cities are given a medium score for climate adaptation through the implementation of publicly accessible local climate adaptation plans, but a low score for green spaces (except Libreville which has a high score) and rainwater separation, which increases vulnerability to climate change. The attractiveness of water bodies is limited due to pollution. In addition, blue infrastructure in cities such as fountains and ponds are very few, and a considerable number of these blue infrastructures are currently out of service.

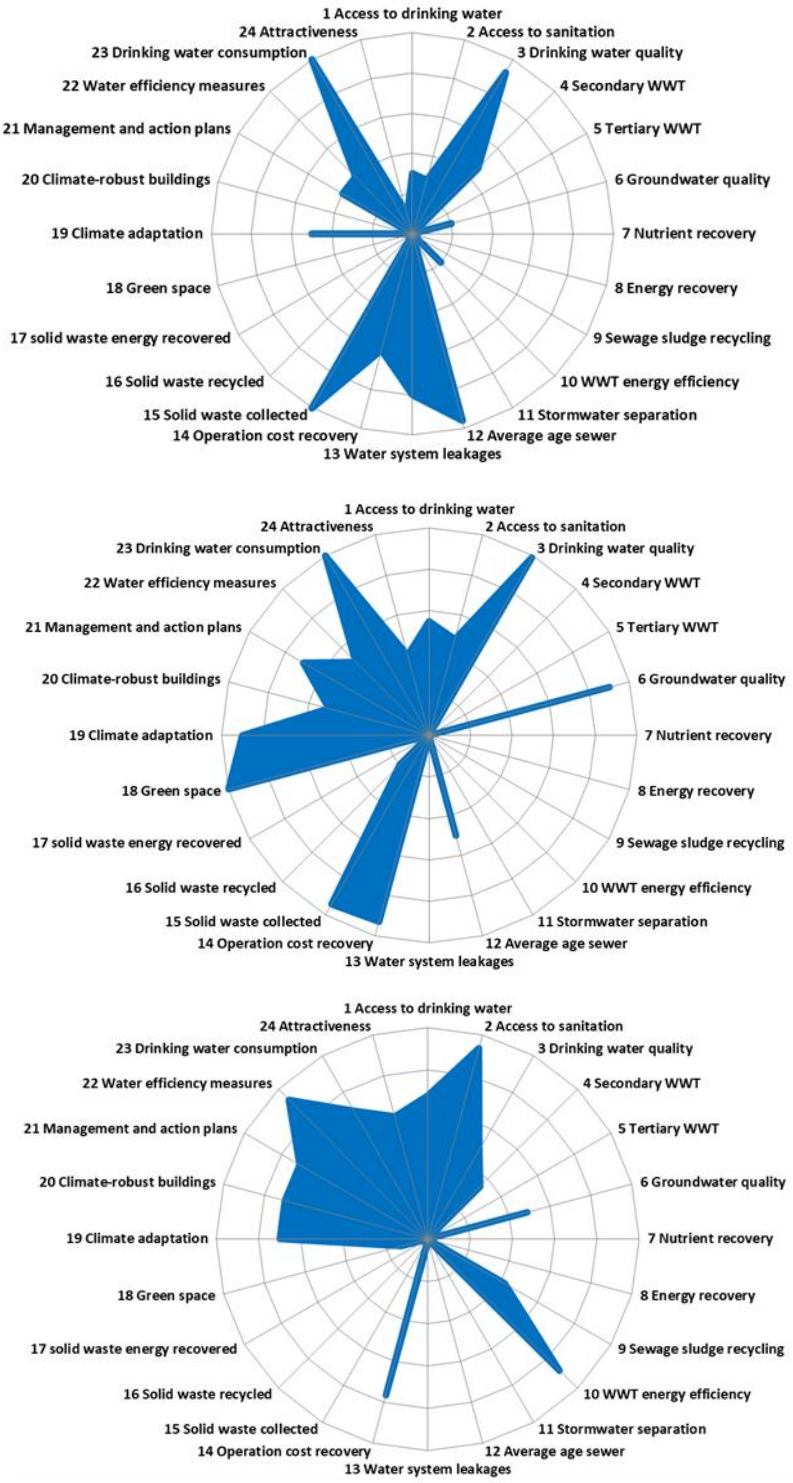

Fig.1: City blueprints of Bangui (top), Libreville (center) and Yaoundé (bottom), based on 24 performance indicators. The geometric mean of the indicators, the BCI scores, are 1.9, 2.6 and 2.7 respectively.

Governance Capacity Framework of Yaoundé

The analyses show seven out of 27 GCF indicators with a very limiting (--) score. Further on, eight indicators returned a limiting (-) score, eight indicators with an indifferent (0) score, two encouraging (+) indicators and one very encouraging (++) indicator. Figure 2 shows the average score for each of the five water-related challenges for the 27 indicators.

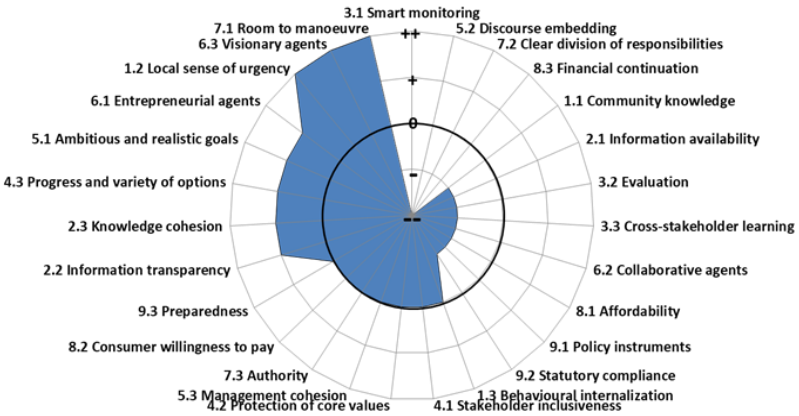

Fig. 2 Results of the GCF analysis of Yaoundé. Limiting GCF indicators, with scores below zero, are 2.1 information availability, 3.1 smart monitoring, 3.2 evaluation, 3.3 cross-stakeholders learning, 5.2 discourse embedding, 6.2 collaborative agents, 7.2 clear division of responsibilities, 8.1 affordability, 8.3 financial continuation, and 9.2 statutory compliance.

Governance capacities to address water scarcity and urban heat islands, respectively, are relatively well developed in Yaoundé. To address these challenges, indicators 1.2 local sense of urgency, 2.2 transparency of information, 2.3 consistency of knowledge, and 5.1 ambitious and realistic management illustrate the well-developed governance capacity to address water scarcity and heat islands respectively. The development of the capacity to address the challenges related to flood risks, wastewater treatment and solid waste treatment have a few indicators that have a limiting (-) to very limiting (--) effect which can be considered a capacity-development priority. In particular, 10 indicators limited the overall governance capacity for almost all water challenges (Figure 2): 2.1 information availability, 3.1 smart monitoring, 3.2 evaluation, 3.3 cross-stakeholders learning, 5.2 discourse embedding, 6.2 collaborative agents, 7.2 clear division of responsibilities, 8.1 affordability, 8.3 financial continuity, and 9.2 statutory compliance. As shown in Figure 2, indicator 2.1 is very limited (--). In Yaoundé, a lack of knowledge which in turn prevents informed decision-making (Rowley, 2007; Van Rijswick et al., 2014). Authorities in many cities recognize the lack of knowledge about how future trends, such as urbanization and climate change, will affect their city (Amundsen et al., 2010). In addition, responsibilities for IWRM are fragmented. They are distributed among a numerous organizations. This fragmentation creates uncertainty due to overlapping responsibilities (Mees et al., 2014).

Conclusions

The challenges of water, waste and climate change in the context of rapid urbanization underline the need for good water management in cities. The objective of the research was to identify priorities for addressing integrated water challenges in Central African cities. In doing so, the City Blueprint Approach was to be tested in three Central African capitals to assess the sustainability of integrated water resources management which consists of three complementary frameworks. Based on the results of these broad diagnostic frameworks the following conclusions can be drawn:

1. **Based on the trend and pressure analysis, vulnerability to river flooding is a major**

concern for two of the three Central African cities. Economic pressure is a major concern for both Yaoundé and Libreville.

2. Based on the CBF, WWT and resource recovery are the highest priorities in terms of improving water management. Often, only primary wastewater and a small portion of secondary wastewater are treated, resulting in large-scale pollution of surface and deep waters. Long-term strategic planning and increased capital investment are required to improve tertiary wastewater treatment, solid waste recycling, nutrient recovery from wastewater treatment, storm water separation, and maintenance and improvement of urban water infrastructure. However, local municipalities, with the support of government and possibly donors, need to take the lead in introducing forms of energy recovery (technology) and tertiary treatment to avoid pollution of surface and groundwater. This will not only provide a source of clean energy, but will also create jobs for the population of Cameroon, especially the youth, and can be cost-effective. In addition, the small area of green spaces in Bangui and Yaoundé increases the vulnerability of flooding during heavy rains due to a lack of water storage capacity, sometimes leading to the destruction of roads and houses. Increasing green spaces in these cities would help fight air pollution.

3. During the information collection process, a lack of open source information was observed. Without transparent data, evaluation and, indeed, learning about existing policies and management practices is severely hampered. Thus, transparency of information is essential to support constructive discussion, evaluation and learning to continuously improve existing policies and management practices.

4. Based on the analysis of the governance capacity of the city of Yaoundé, it is proposed to improve smart monitoring and evaluation of projects and cross- stakeholders learning efforts. For example, through workshops that involve different levels of management, stakeholder empower each other to continuously learn and together make the city's water governance more effective. Integration of discourse, clear division of responsibilities and statutory compliance are among the factors that also need to be addressed. However, sufficient monitoring is first needed to analyse the impact of different measures and policies, to enable accountability and to know whether stakeholders are complying with existing regulations.

References

Amundsen, H., Berglund, F. and Westskogh, H. 2010. *Overcoming barriers to climate change adaptation-a question of multilevel governance?* Environmental Planning C 28, 276–289.

Ddiba, D., Andersson, K., Koop, S.H.A., Ekener, E., Finnveden, G. and Dickin, S. 2020. *Governing the circular economy: Assessing the capacity to implement resource-oriented sanitation and waste management systems in low and middle-income countries.* Earth System Governance 4, 100063.

EIP Water, 2020a. European innovation partnership on water: *Indicators of the trends and pressures framework.* http://www.eip-water.eu/City_Blueprints [Accessed 28 Aug 2020].

EIP Water, 2020b. European innovation partnership on water: *Indicators of the city blueprint framework.* http://www.eip-water.eu/City_Blueprints [Accessed 28 Aug 2020].

EIP Water, 2020c. European innovation partnership on water: *Indicators of the governance capacity framework.* http://www.eip-water.eu/City_Blueprints [Accessed 28 Aug 2020].

EIP Water, 2020d. European innovation partnership on water: *E-Brochure.* http://www.eip-water.eu/City_Blueprints [Accessed 28 Aug 2020].

Koop, S.H.A. and Van Leeuwen, C.J. 2015a. *Assessment of the Sustainability of Water Resources Management: A Critical Review of the City Blueprint Approach.* Water Resources Management. 29, 5649–5670.

Koop, S.H.A. and Van Leeuwen, C.J. 2015b. *Application of the Improved City Blueprint Framework in 45 municipalities and regions.* Water Resources Management, 29, 4629-4647.

Koop, S.H.A., Koetsier, L., Doornhof, A., Reinstra, O., Van Leeuwen, C.J., Brouwer, S., Dieperink, C. and Driessen, P.P.J. 2017 *Assessing the Governance Capacity of Cities to Address Challenges of Water, Waste, and Climate Change.* Water Resources Management, 31, 3427–3443.

Koop, S.H.A. and Van Leeuwen, C.J. 2017. *The challenges of water, waste and climate change in cities.* Environment Development Sustainability, 19, 385–418.

Madonsela, B., Koop, S., Van Leeuwen, K. and Carden, K. 2019. *Evaluation of Water Governance Processes Required to Transition towards Water Sensitive Urban Design—An Indicator Assessment Approach for the City of Cape Town.* Water, 11, 292.

Mees, H.L.P., Dijk, J., Van Soest, D., Driessen, P.P.J., Van Rijswick, M.H.F.M.W. and Runhaar, H. 2014. *A method for the deliberate and deliberative selection of policy instrument mixes for climate change adaptation.* Ecology and Society 19.

Rowley, J. 2007. *The wisdom hierarchy: representations of the DIKW hierarchy.* Journal of Information Science, 33, 163–180.

Van Leeuwen, C.J., Frijns, J., Van Wezel, A. and Van de Ven, F.H.M. 2012. *City Blueprints: 24 Indicators to Assess the Sustainability of the Urban Water Cycle.* Water Resources Management, 26, 2177–2197.

Van Leeuwen, C.J., Hofman, J., Driessen, P. and Frijns, J. 2019. *The Challenges of Water Management and Governance in Cities.* MDPI: Basel, Switzerland.

Van Rijswick, M., Edelenbos, J., Hellegers, P., Kok, M and, Kuks, S. 2014. *Ten building blocks for sustainable water governance: an integrated method to assess the governance of water.* Water, 725-742.

World Bank, 2019. *Open Data*. https://data.worldbank.org/ [Accessed 28 Aug 2020].